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TECHNIQUE FOR INTERACTIVE SYSTEMS ANALYSIS (TISA)

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The field of systems analysis has traditionally been devoted to obtaining the necessary basis for design or redesign of hardware systems. While this analytic capability is no less desirable for "soft" systems, applications in that area have been hampered by data deficiencies, difficulties in system definition and the specification of desired performance, measurement problems, and the like. In response to the problems, a Technique for Interactive Systems Analysis (TISA) has been developed. TISA is a computerized technique for conducting system analysis in a conversational mode from interactive terminals. TISA uses networking

20. ABSTRACT (Continued)

algorithms to access and structure system descriptive data from computer files. It can apply various analyses to these data and has the capability to display resulting system networks through the medium of computer graphics. TISA has been further developed as an analytic tool for the design, development and management of organizational processes.

FOREWORD

The Advanced Development covered in this report is in support of a Manpower Requirements and Resources Control System (MARRCS), being developed as a subproject under Technical Development Plan P43-07X, Manpower Management Effectiveness. The overall objective of MARRCS is to test and evaluate technologies directed toward improved manpower resources management. Phase I of MARRCS involves an analysis of the existing Navy manpower planning and programming processes in order to establish a basis for improving current systems management and future systems development.

The work accomplished in this report was under the direction of Mr. Elmer S. Hutchins, Jr., Phase I Project Director. Overall guidance was provided by Dr. Richard C. Sorenson, Associate Director for Management Systems Research and Development.

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

The field of systems analysis has traditionally been devoted to obtaining the necessary basis for design or redesign of hardware systems. While this analytic capability is no less desirable for soft systems, its application in that area has been hampered by data deficiencies, difficulties in system definition and the specification of desired performance, measurement problems, and the like. As a result, many attempts to perform systems analysis on organizations, for example, have resulted in lengthy verbal products too inescapably static to have a real-time impact on system design. The problem setting which prompted the design of a Technique for Interactive Systems Analysis was one such situation. In this case, an analysis of the Navy's current manpower planning processes was desired as background for a program of developments aimed at improving the effectiveness of that system.

Objective

A Technique for Interactive Systems Analysis (TISA) was developed in order to perform the systems analysis necessary to (1) assess the state of the current system at the onset of a major development effort (i.e., establish a baseline), (2) reveal deficiencies in the manpower system and probable candidates for further R&D, and (3) provide a convenient and effective means for assessing the progress of the development program at any point in its evolution.

Approach

TISA is a computerized technique for conducting system analysis in a conversational mode from interactive terminals. TISA uses networking algorithms to access and structure system descriptive data from computer files. It can apply various analyses as specified to these data and display resulting system networks by computer graphics via functional block diagramming.

TISA has been developed as an analytic tool for the design, development, and management of organizational processes. It provides a technology that permits the use of traditional systems analysis methodologies (e.g., cost-benefit analysis) on "soft" systems in an integrated, computerized, conversational manner. A good example of such a soft system would be that of a management information system (MIS). TISA can represent such a system using as building blocks all the significant communications that comprise the system. These communications are recurring transmissions or receipts (flows) of information in the form of raw or processed data, decisions, guidance, etc.

Conclusion

The initial objectives of TISA are being realized within the MARRCS Phase I project. First of all, both the research and operational communities have been provided access to the analysis tool and its data base. Training of potential users of the system, external to NPRDC, has been conducted and is continuing. The data obtained in the Phase I effort are presently being subjected to intensive analysis, using TISA in connection with standard analytic software. However, more important than any specific analysis is the fact that a means has been provided for system developers to quickly obtain answers to their own questions about the system, to answer unanticipated questions, to test alternatives, and to measure progress.

Aside from the Phase I application, TISA is being used within the Bureau of Naval Personnel (DCNP for Management Information, Pers-3) to assess the present and future ADP requirements of that organization. From this is evolving a descriptive data base similar in form to that of the MARRCS Phase I effort but more than twice the size (i.e., 3000 - 5000 communications). That same data base is also being used in another closely related TISA application within the Bureau of Naval Personnel. In this case, the objective is to uncover strategies and constraints concerning an impending move of part of the organization from its present geographical base, and possible reorganization. Here TISA will be used to answer such questions as "What is the density and criticality of communications between two or more nodes in the organization?"

Recommendations

From these multiple uses, it is anticipated that TISA could be developed into a standard initial analysis approach for soft system development programs throughout the Navy, as well as other organizations. The most promising types of such development efforts appear to be at this time management information system (especially ADP-oriented) and resource management system developments. The emphasis in computer system development currently is in the "data management" area. TISA would seem to be an ideal tool with which to approach this problem.

TISA can also be utilized as a methodological device in more basic areas of research such as organizational behavior, information processing, and human factors. In organizational research, much is made of differences in organizational behavior and effectiveness that may be attributable to organizational structure. However, frequently overlooked is the accuracy of the assumptions about the nature of the structure under analysis. Structure descriptive techniques of the specificity of, for example, a sociogram have not been developed or applied because of the size and complexity of the organizations studied. TISA provides a means for achieving the desired specificity and therefore a greater opportunity for accurately identifying the informal or "real" organization structure and comparing its properties with those of the formal structure or of other alternative configurations.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

A Technique for Interactive Systems Analysis (TISA) is a computerized technique for conducting system analysis in a conversational mode from interactive terminals. TISA uses networking algorithms to access and structure system descriptive data from computer files. It can apply various analyses as specified to these data and display resulting system networks by computer graphics via functional block diagramming.

TISA has been developed at the Navy Personnel Research and Development Center (NPRDC) as an analytic tool for the design, development and management of organizational processes. It provides a technology that permits the use of traditional systems analysis methodologies (e.g., cost-benefit analysis) on "soft" systems in an integrated, computerized, conversational manner. A good example of such a soft system would be that of a management information system (MIS). TISA can represent such a system using as building blocks all the significant communications that comprise the system. These communications are recurring transmissions or receipts (flows) of information in the form of raw or processed data, decisions, guidance, etc.

TISA is appropriate for use in analyzing both computerized and non-computerized information systems. In fact, one of its most appropriate roles is as a means of obtaining a blueprint for the application of ADP technology and for incorporating the most effective design for systemization.[1] More generally, TISA is appropriate for carrying forth the conventional purposes of systems analysis to the sphere of soft systems.

A. Problem

The field of systems analysis has traditionally been devoted to obtaining the necessary basis for design or redesign of hardware systems. While this analytic capability is no less desirable for soft systems, applications in that area have been hampered by data deficiencies, difficulties in system definition and the specification of desired performance, measurement problems, and the like. As a result, many attempts to perform systems analysis on organizations, for example, have resulted in lengthy verbal products too inescapably static to have a real-time impact on system design. The problem setting which prompted the design of TISA was one such situation.

TISA was developed in order to perform the systems analysis necessary to (1) assess the state of the current system at the onset of a major development effort (i.e., establish a baseline), (2) reveal deficiencies in the manpower system and probable candidates for further R&D, and

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[1] TISA is currently being used by the Deputy Chief of Naval Personnel, Management Information, for this purpose.

(3) provide a convenient and effective means for assessing the progress of the development program at any point in its evolution.

Thus, TISA became the primary technique of the large-scale systems analysis effort of the Manpower Requirements and Resources Control System subproject, MARRCS Phase I. Figure 1 presents an overview of the development of MARRCS Phase I, the role of TISA, and the manner in which they support a particular system development program, in this case, the Navy manpower planning system.

B. Scope

TISA was developed to cope with the fine level of detail and broad scope of the Phase I analysis. The objective of this analysis is to obtain data about each significant communication made in the Navy's manpower planning management system. These communications have been characterized as inputs and outputs to various information processing nodes in the system. It was desired to obtain both producer and consumer perspectives on each such communication. At the conclusion of Phase I, TISA will be dealing with 1500 to 2000 individual communications representing the system. The scope of Phase I data collection has included elements of the following organizations:

- Office of the Chief of Naval Operations
- Office of the Chief of Naval Personnel
- Comptroller of the Navy
- Office of Civilian Manpower Management
- Office of the Chief of Naval Material
- Major Claimants
- Sponsors
- Navy Manpower and Material Analysis Center, (Atlantic and Pacific)
- Commander in Chief, Atlantic Fleet
- Commander in Chief, Pacific Fleet
- Chief of Naval Training

Of course, data collection in some of these organizations was more intensive than in others, depending upon the degree to which each organization is actively involved in manpower planning. Sampling was not used; rather, an attempt was made to have all functions relevant to manpower planning represented in the collected data. Through a questionnaire, respondents documented all manpower planning actions involving themselves or their organizations. These actions were viewed as communications (inputs or outputs) and included decisions, information processing, report generation, maintenance of data, operations of models, etc. The types of information collected about each of these communications are explained in detail within this report. It will suffice at this point to say that the scope and magnitude of the data being collected were considerably greater than in any other known study of this functional area.

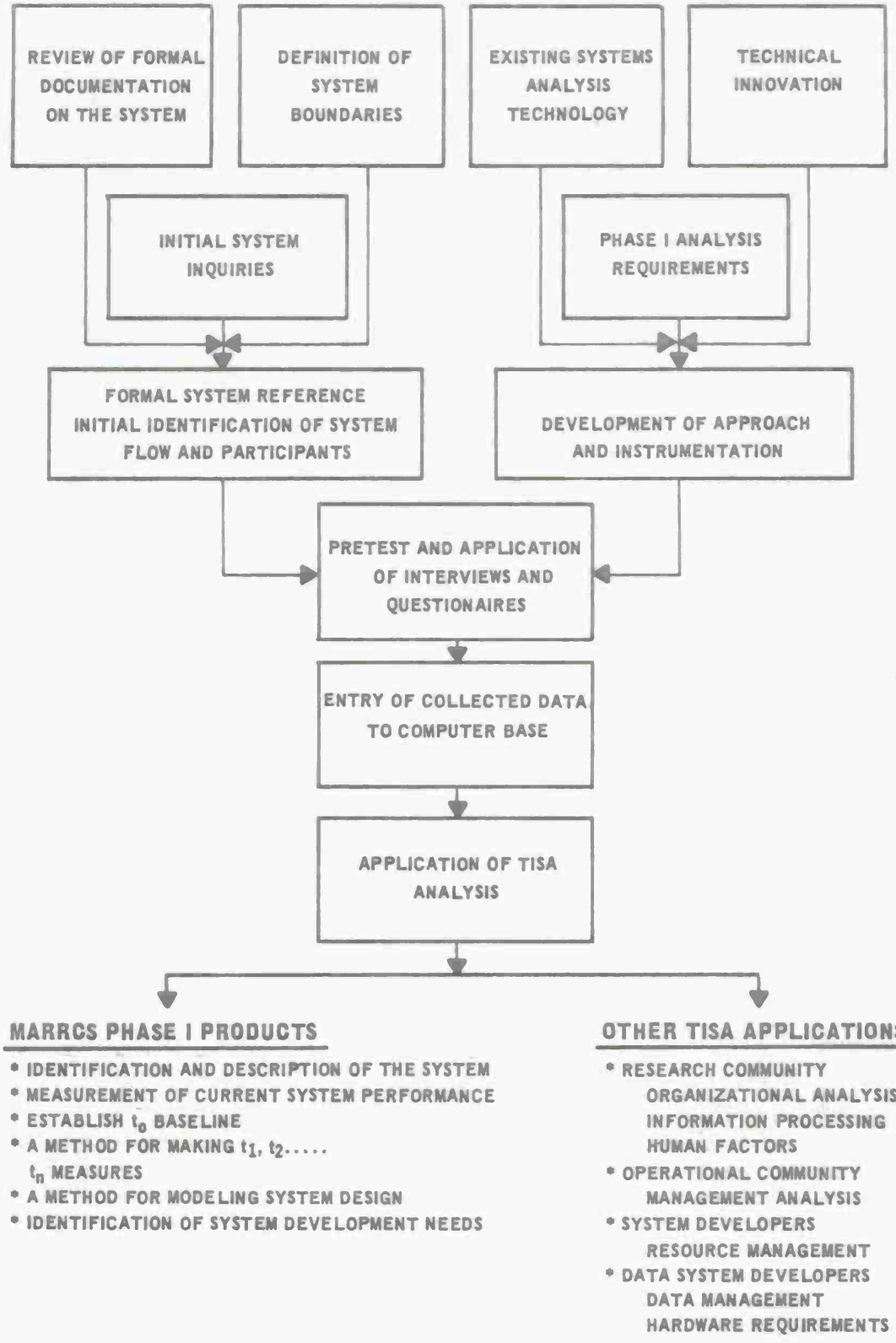

Figure 1. Overview of MARRCS Phase I and the Role of TISA

C. Objective

Aside from the amount of data to be subjected to analysis, TISA was designed to meet certain requirements of data manipulation that analysts considered necessary to the Phase I study. These requirements can be described as: (1) the ability to structure the data in a network flow context; (2) the ability to structure the data in an organizational context; (3) versatility of data access for direct and selective analysis with a variety of routines in an interactive mode; and (4) speed, lucidity, and reliability in the graphical depiction of any system of communications as specified by a selected data set, again without the need for external I/O or manual illustration.

Of these requirements, the first two need elaboration. The structuring of the data in a network flow context entails the formulation of a logical connectivity among identified communications that is based solely on their content and function as opposed to formal/informal organizational distinctions. This context (mode) enables one to simultaneously depict inter- and intraorganizational communications, transcending hierarchical distinctions to the extent that the essential character and role of a process are readily discernible. This mode is well suited to tracking the development of a given information or decision requirement; or tracking the utilization of specified communication(s). Bottlenecks, critical paths, interaction patterns, and chains of impact can be thereby identified. "Breakpoints," which note changes from processes of alternative generation to those of alternative selection, can be geometrically identified.

The second data manipulation requirement, representing organizational context, is the natural complement to the flow concept. This mode identifies the organizational locus of a process or set of processes. It provides a hierarchical map for a flow network that distinguishes horizontal and vertical information flows and provides access to these flows via an organizational index. In a sense, it provides the formal organization complement to the flow context described above.

Another aspect of TISA is its intended utility as an end product. The MARRCS Phase I study is geared to produce a dynamic and durable systems reference through the medium of TISA, resulting in more than "a report." Most system development efforts regardless of context, call for an initial diagnostic effort that describes and often evaluates the "as is" system. A problem with such an effort is that operational systems do not stand still for analysis. Within the time it takes to go from collected data to written report, the system may have changed in ways significant enough to invalidate many of the findings, making "as is" more like "as was."

Even if diagnostic results can be reported before they are antiquated, an even more formidable problem remains. This is the problem of getting new system developments or modifications "on line" while they are still appropriate to the system. In addition, system development efforts may go on for several years. How are the diagnostic descriptions and conclusions to be updated? While recommendations for updates may be conscientiously

made by diagnosticians, few, if any, resources are often afforded to that activity once a developmental effort is going full ahead. To be effective, it is essential that systems analysis be used to guide system evolution as opposed to chronicling it.

Running somewhat counter to the above difficulties is the fact that frequent evolutions of a system can be manifestations of a fairly persistent set of problems that have not been satisfactorily resolved. Thus, if the diagnostic effort does a good job of distinguishing symptoms (e.g., frequent reorganizations and policy revisions) from illness (e.g., unsatisfactory allocation of resources), its results will have a much longer and useful life, since subsequent developmental efforts will be much more efficacious. It was this sort of thinking that led the authors to spend considerable time at the beginning of Phase I in obtaining a conceptual model of the operational system to which the manpower planning system should be responsive (Barefoot and DiGialleonardo, 1974).

In summary, a diagnostic technique was sought that would allow the systems analysis to be easily maintained and updated, while at the same time be particularly sensitive to the more permanent and underlying factors of the system. The technique developed is intended to minimize the static nature of the systems analysis. It would be more than a reference to a point in time, but rather a dynamic reference that could drastically increase the shelf life of the standard organizational diagnosis.

TISA could also have potential for use as an indoctrinating and interface facilitation instrument. The system under study witnesses a constant and large influx of new people. The scope of the total system is so broad and the immediate needs of its subsystems are so great that few of these new people are afforded the benefit of obtaining the total system concept. The systems analysis, if formulated as specified above, could serve as a tool for reducing discontinuities in the system due to turnover and improve the learning curves for new people. People outside the system also are in constant need of a reference for identifying who or what it is they must deal with to answer a given manpower question. Given the necessary medium, the results of the system analysis could serve as an interface facilitator and organization/function index for these people.

II. APPROACH

A. TISA Structure

Figure 2 presents an overview of the structure underlying the TISA package. The collected data is ordered into two files that form the data base, the communication file (COMM) and the directory file (DIR). By far, the most important of the two is the COMM file. This file contains all of the data relevant to communications and thus holds the bulk of the collected data. The DIR file reflects data relevant to respondents, as opposed to communications (e.g., length of time the respondent has been in current position).

Many of the records in the COMM file can be identified as pairs of producer/consumer perceptions concerning a given communication. There are three main TISA modules: Conversational Search Program (SEARCH), Conversational Attribute Analysis Program (CAP), and Network Analysis Program (NAP). Figure 2 indicates that the three TISA program modules each respond to a different dimension of system interrogation. The SEARCH program operates on node criteria. That is, if communications are viewed as a network, SEARCH will create sets and subsets on the basis of which nodes (sources and sinks) of the network are of interest. In the main, SEARCH operates on a "from" - "to" address that begins every record in the COMM file.

The CAP module analyzes attributes and combinations of attributes associated with each communication (i.e., a COMM record). The word attribute is used in referring to the various kinds of information about each communication that were supplied by respondents via a questionnaire. The user questions CAP about the value or existence of the attributes in a given set of communications (i.e., a network) and composes sets through the combinatorial application of these criteria. The CAP program analyzes attributes in both raw and computed forms--the former being data directly entered in the files from the questionnaires, the latter being indices, ratios, averages, etc. computed from those raw data.

The Network Analysis Program (NAP) works with criteria that issue from the flow context of a communication or group of communications. In NAP the user is concerned with order of communications, chains of impact, which organizations are members of a given decision chain, etc. Like SEARCH and CAP, NAP's conversational language is structured around Boolean set manipulations. In addition, NAP has the capability of automatically drawing a flow diagram which represents a subject set of communications. Furthermore, the drawing itself can be modified by the user interactively (e.g., remove or add communications).

Formulated files or subsets can be freely passed among the TISA modules There are no constraints in moving from one TISA module to any other. Figure 2 also refers to stored reference FBD's (functional block diagrams) and OSD's (operational sequence diagrams). These are other graphics software that can augment TISA. FBD's provide the ability to "nest" organizational maps within one another. OSD's automate the traditional Operational Sequence Diagram which lends itself nicely to the study of work flows when a small number of

TISA STRUCTURE

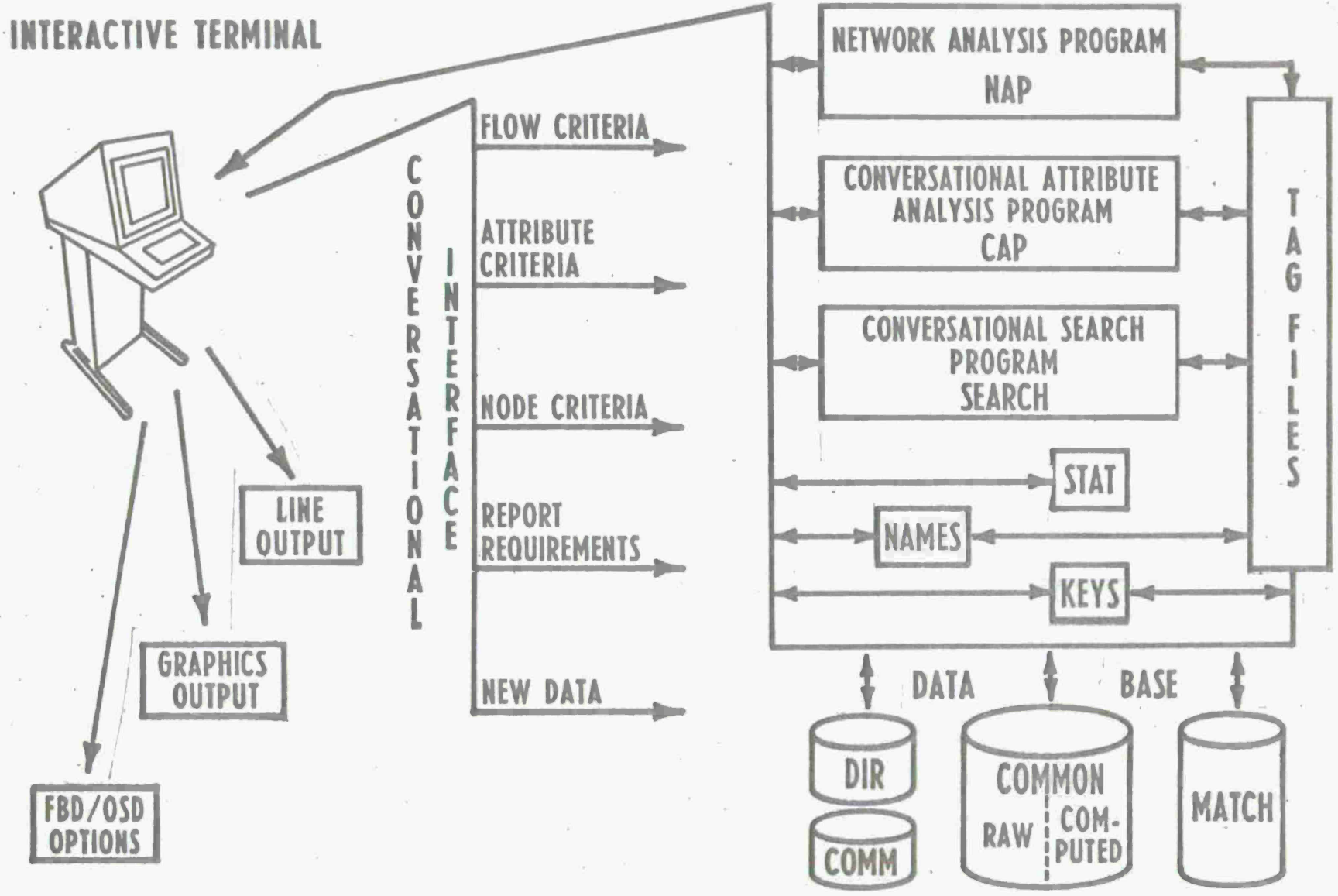

Figure 2

objects are being processed by many organizations over time. While FBD's and OSD's draw automatically and can recall previously composed drawings, they do not draw directly from the data base as in the case of NAP. Rather, the desired linkages must be entered by the user at the terminal.

The NAP module is based on the FBD and OSD graphical work developed by Barten and Associates of Santa Monica, California, for the Naval Electronics Laboratory Center (NELC). Barten and Associates also assisted in development of certain routines within the TISA package.

A much more detailed explanation of the TISA structure and operating instructions can be found in the TISA Users' Manual (Barefoot, Blanco, and Gasper, 1975).

B. SEARCH

The SEARCH program builds sets from the data base or other specified files using node codes specified by the user. A node code is a code assigned to each respondent and may represent any individual, group, or organization. These codes are selected to have relevance to real-world names for elements of the system. For example, in Phase I, it has been convenient to assign most node codes the prefix OP with the appropriate numerical code suffix corresponding to actual real-world designators (e.g., ØP 100). Node codes are presently limited to seven characters.

Each communication record begins with a pair of node codes. The first code is that of the respondent for that communication (i.e., the node that identified the communication in its questionnaire). The second code is that of the sender or receiver of the communication (a given communication may be an input or an output). For purposes of differentiation, the latter code is referred to as the "communication identifier." The two codes together form an identification tag for the rest of the record - for example, ØP 100, ØP 102. The tag also carries numbers identifying the communication as an input or output (1 or 0). Inputs and outputs are further designated by letter and number sequences, respectively. If two records are matched, each will carry the output number of the producer (signifying which of his outputs) and the input letter of the consumer (signifying which of his inputs).

Upon entering SEARCH, one specifies the name of the file upon which he wishes to operate. This file may be the COMM File, the MATCH File, or any other previously created set of records. For the purposes of SEARCH, the records in these files need only contain the tags described above, since the program is uniquely concerned with node criteria.

C. CAP

CAP analysis can be performed on input files generated by other TISA program modules (e.g., SEARCH or NAP). These files may contain either matched or unmatched records. However, CAP provides additional and highly significant analytical power for matched record files by comparing producer and consumer viewpoints. CAP analyzes the data in the entered file and produces files containing four levels of information.

Level 1 contains a producer and/or a consumer view of the various attributes of each communication. Some examples of attributes are percent contribution, received value, percent utilization, and overall benefit. A listing of these attributes is included in the TISA Users' Manual (Barefoot, Blanco, and Gasper, 1975).

Level 2 contains a producer and a consumer view of the various attributes of each product. In level 2, consumer views of level 1 are averaged for each product. Level 3 contains a producer and a consumer view of the various attributes of each node. In level 3, both producer and consumer views of the products in level 2 are averaged for each node. In level 4, averages are computed for the system as a whole. These system averages are figured directly from communication level data.

CAP allows the user to interrogate these files in an interactive time-sharing computer mode. Questions can be asked about attributes or combinations of attributes for any specified level of data. A listing of attribute numbers and definitions can be obtained at the beginning of the execution of the CAP program. Instructions on how to make a proper information request can also be obtained at the terminal.

A selection process is initiated by specifying which level of analysis is desired. A series of questions may be asked for each particular selection. These questions are posed by specifying an attribute number, a relational operator, and a value. The attribute number denotes any of the 88 descriptive or evaluative items contained on the common data base record for a single communication. The relational operators can be any of the following:

LT - less than

LE - less than or equal to

EQ - equal to

GE - greater than or equal to

GT - greater than

The value can be any number within the range of the examined attribute variable. For example, to isolate all candidates with a potential benefit (attribute 1) of 3 or less, the following instruction would suffice:
01LE3.0

Each request is checked for structural validity. If the request is vvalid, the number of candidates meeting the request is computed. If no cadidates meet this request, the request is ignored and a new request can be made. If one or more candidates meet this request, the number meeting this request is typed on the terminal. Simultaneously, a count is made of the number of candidates meeting all requests thus far initiated. The number of candidates that meet all requests is also displayed. Further requests can be made in a similar manner, thus further delimiting the object

set. When no candidate meets all requests, the most recent request is ignored, and the user is asked to please make another request. (This saves any combinatorial string that has been composed thus far.) The user can make an unlimited number of requests in a particular selection in order to define the members of his output set with his desired attribute specifications. The user can end the questioning period for a selection at any time by pressing the carriage return. Upon demand, a terminal listing of all candidates meeting all requests of the first selection and their attributes will be provided. After this listing, the user is asked whether he would like to save this set. The process continues for as many selections as the user wishes to make.

D. NAP

NAP is conceived as an interactive tool for analysis and manipulation of the communications network model aspects of the COMM file. It accepts as input files any tag file formerly created by itself (subsequently stored for later use) or any of the other TISA modules. The structure of the data base created by NAP for its internal use is a pure communications network representation of the input file. The primary analytical faculty of the program is manipulating sets of nodes in this internally generated communications network. The analyst may create and name sets of nodes by specifying definitional properties which select nodes from the communications network. He may then combine, modify, list, or graphically display nodes in his originally defined sets.

In diagrams drawn by the system, producer and/or consumer nodes are represented by hexagonal blocks, while communications are represented by open square bracket blocks. NAP provides commands to create new generator nodes or communications, connect existing ones in new ways, and permits the user to define and reference names for sets of nodes and communications.

A set is a collection of nodes which exist in the data base. The nodes which are included in a set are said to be members, or elements, of that set. A set may be composed of as few or as many elements as the user wishes, from none to every node in the data base. Usually the elements of a set share some common attribute in which the user is interested.

E. NAMES and KEYS

The NAMES and KEYS programs comprise the principal report generation mechanism within TISA. The NAMES program is designed to produce up to 12 different reports containing communications attribute data directly from the common data base. KEYS, on the other hand, provides access to the Directory File information and enables the production of three different kinds of reports. Both accept as input the tag files created by any of the principal TISA analysis modules.

NAMES provides the user with the ability to extract information from the common data base about the communications in his input file. The 12 report species appear in Table 1. Any one of these reports can be displayed on the terminal or printed on a line printer.

TABLE 1

NAMES AND KEYS REPORT SPECIES

NAMES Report Species

1. Communication Name
2. Continuity
3. Time
4. Communication Tone
5. Format
6. Information Type
7. Frequency
8. Production Costs*
9. Benefits
10. Sponsor Context
11. Ideal Manpower Configuration for Production*
12. Characteristics (i.e., dialogue, variability, etc.)

*Relevant for outputs only

KEYS Report Species

1. Organizational Name
2. Interviewee Name and Telephone
3. Analytic Incidentals

The KEYS program can be used to generate three separate reports containing node descriptive data about all the nodes identified in the tags of a particular input file. It would ordinarily be applied to generate a "key" for a NAP diagram on which the various organizational nodes are identified only by their node codes. The three report species for KEYS appear in Table 1.

F. Summary of Kinds of Information Presently Contained in the TISA Data Base

The analyses embodied in and permitted by TISA relate to the many attributes (currently 88 in number) associated with each communication, as well as the tag and directory information discussed above. The listing of attributes accessed by the CAP module has been previously referred to. However, it may be helpful at this time to review the various kinds of information accessed by TISA in the Phase I study.

This set of information was designed to arrive at measures of the system that will most facilitate and advance future system development efforts in the MARRCS program. This particular set of attributes is a direct result of the work discussed in the approach and instrument development report (Barefoot and DiGialleonardo, 1974). While this attribute set may serve not only for the analysis of the Navy's manpower planning process but also for the analysis of information systems in general, the structure of TISA is amenable to the introduction of a different attribute set to solve other types of problems (e.g., job and task analysis).

TISA provides the capability for obtaining an average value for any attribute on either a communication (consumer), product, node, or node cluster (system) basis. Thus, for a given measure, say benefit, it is possible to determine (1) average benefit for a random set of communications (e.g., all communications of a certain category), (2) average benefit for a product (i.e., as averaged over all its consumers), (3) average benefit for a group of products (e.g., all outputs of a given node), and (4) average benefit for a group of nodes (e.g., all nodes in a given organization or the total system). The above averages can be obtained for either producer or consumer viewpoints, or both for purposes of contrast. Furthermore, the analysis may begin in any one of three ways:

1. With a specified attribute or set of attributes (here one begins by seeking to identify which communications in the data base possess a particular attribute(s) or possess a certain amount of each attribute),

2. With a specified set of nodes or communications (here values for any or all of the attributes are obtained for the set), and

3. With a specified relationship or flow among a set of nodes (here the flow specifies a set of nodes for which attribute values are then obtained).

Communications can be categorized, tallied, cross-tabulated, and correlated according to the categories of attributes listed below. In addition, communications may be accessed by specifying any combination of these attributes as parameters.

1. Functional Categories: Is the communication

   a. A scenario, projection, or forecast: "what if" questions or answers?

   b. A review, evaluation, feedback, sanction, concurrence or nonconcurrence, or reclama?

   c. An identification of variables, factors, or problem elements; or a structure for considering them?

   d. Quantitative information, or numbers associated with problem elements?

   e. A direction, statement of policy, or procedures to be followed?

   f. A specification of available resources or resource constraints?

   g. A documentation of a processing method, technique, or approach?

2. Depictive Categories:

   a. Format:
      Prescribed (formal) (vs informal)
      Written (vs oral)
      Routine (vs special)
      Request
      Response

   b. Tone:
      A suggestion
      A recommendation
      A guidance
      A directive
      A command

   c. Frequency:
      Reported yearly
      Reported monthly
      Reported weekly
      Reported daily
      Reported on request

   d. Support:
      Accompanied by substantial informal dialogue

3. Contextual Categories: (These are usually specific to the system being studied)

   a. Produced as a Major mission sponsor requirement

   b. Produced as a force/function sponsor requirement

   c. Produced as an appropriation sponsor requirement

   d. Produced as a program element sponsor requirement

   e. Produced as a Navy-wide support sponsor requirement

   f. Produced as a program sponsor requirement

   g. Produced as a military manpower claimant sponsor requirement

   h. Other (Specified by respondent)

In addition to the typological dimensions listed above, a variety of analytic/evaluative information is provided. Cost data are obtained from respondents as derived from the man-years of (1) civilian professional, (2) civilian clerical, (3) officer, and (4) enlisted labor categories consumed in the yearly production of each of their outputs. These figures are multiplied by cost formulas developed for each category on a life-cycle, total cost basis. (Statistics on the cost data will be made available at the conclusion of the Phase I study.) A total cost for each of the outputs of each node is thereby developed. In addition, a shared cost is computed by dividing total cost of an output by the number of consumers of that output. In the data collected thus far, manpower is by far the most significant cost element. However, in cases in which a node is incurring significant data processing costs, these too are noted for later analysis.

In addition to direct cost, opportunity cost of not making a decision or not producing a given output should be considered in a decision about its effectiveness. Unfortunately, since this study is not being conducted in a controlled setting, these kinds of cost are difficult to determine. However, this is mitigated by the fact that once the system analysis is completed, it will be possible to trace chains of decision-making impact to the extremities of the system. If a certain output is not on a chain of impact, there will be in effect zero opportunity cost attached to ceasing its production. At that point, the question will be whether the system should be developed so as to take advantage of the output if it is in fact useful or whether the output, in truth, serves no real use, given the current and planned system scenario.

The cost data can be used in any number of ways, such as developing total cost for a chain of outputs (cumulative cost), developing cost/benefit ratios, and determining windows of opportunity (e.g., critical

outputs that can greatly increase their impact if afforded small cost increases). Since respondents were asked to supply an "ideal" labor combination, the resultant ideal cost can be contrasted against actual cost to see whether significant understaffing is thought to exist and where.

The difficulties of performance measurement in the subject system and underlying theory of the approach formulated to deal with it are discussed in detail by DiGialleonardo and Barefoot (1974). The three primary factors measured to assess benefit are the following:

1. Potential Contribution - The contribution made by the information if it were perfect and full use were made of it (Measured on a 0 - 4 scale of "no contribution" to "very high contribution").

2. Received Value - The portion of potential contribution that is normally received, given the production constraints and performance of the producer (a percent).

3. Utilization Value - The portion of received value that is normally applied by the information consumer, given his resource constraints (a percent).

The product of these three factors is termed benefit or "realized" benefit. These measures may reflect the viewpoint of the output producer, the consumer, or both. A consumer/producer ratio is generated for the latter case.

$$\frac{\text{Consumer's perception of benefit}}{\text{Producer's perception of benefit}} = \text{Congruence Index}$$

Value of the Index	0	1	+
	Producers see more benefit than do consumers	Producer and Consumer agree as to benefit	Consumers see more benefit than do producers

The consumer/producer ratio can be used as a developmental tool, since the congruence measure serves a purpose independent from its cause-effect meaning. This point warrants elaboration. The index is not free of the difficulties of perceptual set. That is, while a given index may be greater or less than one, this difference may be showing only disagreement over what constitutes "high benefit" as opposed to disagreement over the actual effect of the communication. Producer and consumer may be in agreement over this latter point. Still, the congruence index can serve a valuable role from the system development standpoint by simply identifying such disagreement, be it over the effect, the value of the effect, or both. Once the lack of congruence has been identified, further steps can be taken in developmental efforts to iron out whether there is a requirement for a change in performance, a change in performance specifications, or changes in both.

In addition to the benefit factors thus far identified, data are also collected to determine whether responses to the benefit questions are based on feedback from the corresponding producer or consumer. Another question is asked to determine whether the information being evaluated is used for purposes other than manpower planning. This is to guard against any judgments that might be made as to the desirability of a given communication on its manpower planning benefit alone.

Tests will also be made to see if any selected set of communications sharing a common characteristic(s) is significantly different from the population of communications with respect to any or all of the three benefit factors. Implications might then be drawn as to which characteristics are most important to the value of a certain type of communication or decision. For example, it may not be surprising to find that information of a highly quantitative type is perceived as having very high potential contribution but low received or utilization value due to the difficulty of obtaining and using such data. While this example is somewhat trivial, the capability it demonstrates is not. It is expected that this kind of analysis can systematically turn up valuable insights to improving the current system that have not been previously seen.

The TISA data base also contains the following:

1. Realization/Potential Ratio - Another fairly straight-forward indicator of system development potential is the relationship of potential benefit to the realized benefit as measured by the three-factor product.

2. Realized (Computed) Benefit - Index of potential contribution realized.

3. Average Benefit - As explained above, CAP has the capability of determining various averages. An average benefit figure computed for a specified information chain (identified in NAP) can become the numerator in a Benefit/Cost index for which the denominator is a cumulative cost figure as described in the cost section above.

4. Continuity is an obviously important system element. In view of the military staffing of much of the manpower planning system, this becomes of particular importance to the Phase I analysis. Data on three types of continuity are obtained:

a. Length of time individuals have been in the system (tenure),

b. Length of time a node or function has existed, and

c. Length of time a communication has been received or produced.

As with other measures, these continuity data can be computed on communication, product, node, node cluster, or typological bases. Some interesting indicators can result. For example, average tenure for individuals in the system can be computed. However, it is well to contrast this with average tenure broken out on a communication basis. The latter shows the tenure of the person making the average communication. Thus, if the system operates in a manner such that only individuals with considerable tenure actually make communications and new people are first used in support, then the average tenure could be substantially lower than tenure broken out by communications.

5. Accuracy - Respondents are asked to indicate the relative accuracy they attach to each of their inputs. This is measured on a four-point scale (0 - 3). The computations performed on accuracy data are parallel to those described for the other measures discussed in this section. However, the data were intentionally gathered for the consumer perspective only, under the assumptions that producers would be highly biased and the consumers' viewpoint is of particular interest for this measure.

It is expected that the "accuracy" data will not be pure in the scientific sense of the word. That is, it is expected consumers will also read into this question the effects of factors such as reliability and validity. This should not seriously hamper use of the data in system development. Furthermore, it would not have been feasible to ask respondents to make the scientific distinctions among these criteria. Wait time is assessed for inputs in the same manner as accuracy. Again, a four-point scale is used.

III. FINDINGS

A. Current Applications

The role of TISA in the MARRCS Phase I effort to support the development of a Navy Manpower Planning System has been described in considerable detail in earlier sections of this report. The initial objectives of TISA are being realized within this project. First of all, both the research and operational communities have been provided access to the analysis tool and its data base. Training of potential users of the system, external to NPRDC, has been conducted and is continuing. The data obtained in the Phase I effort are presently being subjected to intensive analysis using TISA in connection with standard analytic software. The results of this analysis are planned for publication during 1975. However, more important than any such report is the fact that a means has been provided for system developers to quickly obtain answers to their own questions about the system, to answer unanticipated questions, to test alternatives, and to measure progress.

Aside from the Phase I application, TISA is being used within the Bureau of Naval Personnel (DCNP for Management Information, PERS-3) to assess the present and future ADP requirements of that organization. From this is evolving a descriptive data base similar in form to that of the MARRCS Phase I effort but more than twice the size (i.e., 3000 - 5000 communications). That same data base is also being used in another closely related TISA application within the Bureau of Naval Personnel. In this case, the objective is to uncover strategies and constraints concerning an impending move of part of the organization from Washington, D. C. to New Orleans, and possible reorganization. Here TISA will be used to answer such questions as "What is the density and criticality of communications between two or more nodes in the organization?"

B. Planned Applications

TISA will be used as a general-purpose analytic tool throughout future phases of the MARRCS program. For example, within the Navy's current manpower planning procedures, there is a need to better relate the manpower requirements of the shore establishment to fluctuations in the requirements of the operating forces. TISA can be used to describe and analyze the pertinent linkages in a multidimensional manner. It may also be possible to generate model prototypes via this procedure. It is also planned to develop the TISA methodology further on the basis of insights derived in the Phase I and BUPERS applications.

IV. RECOMMENDATIONS

From these multiple uses, it is anticipated that TISA could be developed into a standard initial analysis approach for soft system development programs throughout the Navy, as well as other organizations. The most promising types of such development efforts appear to be at this time management information system (especially ADP oriented) and resource management system developments. The emphasis in computer system development currently is on the "data management" problem. TISA would seem to be an ideal tool with which to approach this area.

TISA can also be utilized as a methodological device in more basic areas of research such as organizational behavior, information processing, and human factors. In organizational research, much is made of differences in organizational behavior and effectiveness that may be attributable to organizational structure. However, frequently overlooked is the accuracy of the assumptions about the true nature of the structure under analysis. Structure descriptive techniques of the specificity of, for example, a sociogram have not been developed or applied because of the size and complexity of the organizations studied. TISA provides a means for achieving the desired specificity and therefore a greater opportunity for accurately identifying the informal or "real" organization structure and comparing its properties to those of the formal structure or of other alternative configurations.

In the information processing area, TISA could provide a way of analyzing the complex flows of information and the way they impact upon actions and decision making. The human factors field could also possibly benefit from the development of TISA, for example, in the task of developing actual work center configurations from the basic starting points of a task array and human performance capabilities/requirements. Here the necessary task elements could be entered as the data base along with the associated requirements, characteristics, and linkages for each (e.g., time to perform, skill requirements, required linkages with other task elements, etc.). TISA could then be used to approach an optimal aggregation of these task elements into jobs and finally translate these into people requirements.

References

1. Barefoot, David B., Blanco, Thomas A., and Gasper, Elon J., "Technique for Interactive Systems Analysis (TISA) - Users' Manual", NPRDC Technical Report, Navy Personnel Research and Development Center, San Diego, California (forthcoming), 1975.

2. Barefoot, David B., and DiGialleonardo, Frank R., "An Approach and Instrumentation for Management System Analysis", NPRDC Technical Report 75-20, Navy Personnel Research and Development Center, San Diego, California, October 1974.

3. DiGialleonardo, Frank R., and Barefoot, David B., "An Approach for Measuring Benefit and Cost in Management and Information Systems", NPRDC Technical Report 75-21, Navy Personnel Research and Development Center, San Diego, California, October 1974.

APPENDIX

DEMONSTRATION OF TISA USE

Appendix

DEMONSTRATION OF TISA USE

The best way to illustrate the application of TISA is to show how TISA operates through some specific examples. This appendix presents two such examples. Example 1 selects and analyzes a set of matched records (producer and consumer views are present on records which are sorted and then matched) of communications which circulate internally within a specific subsystem (the ØP-01 organization). Example 2 analyzes a particular system node at its interfaces with the external community.

In both examples, the SEARCH program will select the initial set of communication records to be analyzed (though the TISA modules can be used in any order). CAP will then be used to compute the various communications' attributes, and allow the user to ask questions by specifying the attribute criteria which the desired communication set must satisfy.

For a matched record communication set, CAP creates attribute information on four levels: communications, products, nodes or organizations, and the system. Average consumer and producer attribute views are computed for all levels above the communications level. For unmatched records, CAP only computes attributes on the communications and system levels.

NAP is capable of isolating and displaying flows in communication networks by specifying sets with NAP's command language. NAP can graphically display any set of communication flows the user desires. In addition, it permits the evaluation of proposed modifications to existing systems.

All programs within TISA are conversational. The user interacts with the computer by entering commands at the terminal and responding to questions asked by the programs.

Example 1

To start the TISA executive program, the user types the command:

```
RUN TISA
```

The TISA executive program responds by displaying the word:

```
NEXT:
```

At this time the user enters the name SEARCH, CAP, or NAP. The programs can be run in any order.

In example 1, the user starts off by typing the command:

```
SEARCH
```

The SEARCH program responds by displaying:

```
TYPE IN A 5 CHARACTER INPUT FILE NAME
```

Since this example only considers matched records, the user types the name of the matched record file:

```
MATSS
```

SEARCH then responds by displaying:

```
IF THE FILE IS RAW - TYPE YES, ELSE NO
```

The matched record file is not a raw file (i.e., it is obtained from the common data base) so the user answers:

```
NO
```

SEARCH next makes a request to the user by displaying:

```
PLEASE TYPE A 5 CHARACTER FILE NAME FOR THE INCLUSIVE
SEARCH FILE
```

For this example the user names the inclusive search file by typing:

```
INCL1
```

Next SEARCH asks a question by displaying:

```
READY TO PERFORM EXCLUSIVE SEARCHES?
IF YES, TYPE YES.  IF NO, TYPE NO.
```

No inclusive searches have been done yet, so the user is not ready to perform exclusive searches at this time. He types:

```
NO
```

The SEARCH program then displays:

```
TO SEARCH ON NODE CODE, TYPE N.
TO SEARCH ON COMM ID, TYPE C.
TO SEARCH ON BOTH, TYPE B.
IF NO MORE SEARCHES ARE TO BE PERFORMED,
PLEASE TYPE X
```

To search on the node code the user types:

```
N
```

The SEARCH program then asks for the list of node codes to do the inclusive search. It does this by displaying:

```
PLEASE ENTER NODE CODES TO SEARCH ON.
INSERT CHOICES ONE AT A TIME AFTER THE
ASTERISKS.  A MAXIMUM OF THIRTY CODES WILL
BE ACCEPTED FOR A SINGLE PASS.
WHEN ALL THE NODES ARE INPUT, INSERT
XXXXXXX AFTER THE ASTERISK.  OK?
*
```

In example 1, the user responds by entering all the node codes of a particular system of nodes (called OP-01) that currently are respondents in the data base:

```
ØP001CC
*
ØP01CE
*
ØP100
*
ØP101
*
ØP102
*
ØP103
*
ØP104
*
ØP121
*
ØP124
*
ØP125
*
XXXXXXX
```

SEARCH finds all records on the input file MATSS containing any node in the submitted list and outputs these records to the inclusive search file INCL1. The SEARCH program then displays in this example:

```
NUMBER OF RECORDS FOUND THIS SEARCH - 53
NUMBER OF RECORDS FOUND THUS FAR 53
NODE CODE                  NUMBER FOUND
ØP001CC                           3
ØP01CE                            2
ØP100                            18
ØP101                             3
ØP102                             8
ØP103                             8
ØP104                             2
ØP121                             2
ØP125                             3
```

At this time the user has the option of continuing to build the inclusive search file or going on to perform exclusive searches. The SEARCH program displays:

```
READY TO PERFORM EXCLUSIVE SEARCHES?
IF YES, TYPE YES.  IF NO, TYPE NO.
```

In this case, let us assume the user has satisfied his inclusive set requirements and proceeds to the exclusive search by entering:

```
YES
```

The SEARCH program then asks the user to name the exclusive search file and displays:

```
PLEASE TYPE A 5 CHARACTER FILE NAME
FOR THE EXCLUSIVE SEARCH FILE.
```

The user responds by naming the file:

```
EXCL1
```

(The exclusive search could have been entered into directly with a previous file)

SEARCH then displays:

```
TO SEARCH ON NODE CODE, TYPE N.
TO SEARCH ON COMM ID, TYPE C.
TO SEARCH ON BOTH, TYPE B.
IF NO MORE SEARCHES ARE TO BE PERFORMED,
PLEASE TYPE X
```

To do the exclusive search on the communication identifier, the user types:

```
C
```

Again SEARCH explains that it can accept a maximum of thirty node codes at a pass, and "XXXXXXX" signifies the end of a user submitted node code list. In this example, since the user is interested only in communications that occur within the OP-01 system, he submits the same nodes used for INCL1. SEARCH finds all records on the inclusive search file INCL1 containing a communication identifier with a node code on the submitted list. These records are output to the exclusive search file EXCL1. SEARCH then displays:

```
NUMBER OF RECORDS FOUND THIS SEARCH - 36
NUMBER OF RECORDS FOUND THUS FAR 36
NODE CODE                NUMBER FOUND
 ØP001CC                        1
 ØP01CE                         2
 ØP100                         12
 ØP101                          1
 ØP102                          6
 ØP103                          5
 ØP104                          2
 ØP121                          2
 ØP124                          3
 ØP125                          2
```

The user then ends the search process by typing:

X

In this example, 36 records or 18 matches are found and output to the exclusive search file EXCL1. The user now has a set of matched records of communications which circulate internally within the ØP-01 organization. Just before ending, the SEARCH program displays:

```
SEARCH FILES CLOSED.  USE SOS TO SEE THEM.
THANKS FOR YOUR COOPERATION.
WANT TO SEE THE OUTPUT FILE?  YES OR NO.
```

To display a listing of the communication names, the user types:

YES

The SEARCH program returns with:

FILE NAME?

and the user responds with:

EXCL1

SEARCH is thereby linked into the NAMES report generator program. The user can see any of the twelve categories of reports explained earlier in the body of this report. One of these report options, communication name, lists the node codes, output numbers, communication identifiers, input/output designators, and communication names of the records. In the example, this was done for the records on the file EXCL1. See Table A-I for the complete listing.

The user is now returned to the TISA executive program which displays:

NEXT:

Table A-I

COMMUNICATION NAME LIST FROM SEARCH IN EXAMPLE 1

"TAGS"

Node Code	Output No. / Comm I.D.	I/O Des	Communication Name	
OP1ØØ	3OPØØ1CC	1	JOINT TBLS DIST FOR ACT	}
OPØØ1CC	3OP1ØØ	Ø	ANNOT COPIES JTDS/JCS ACT	} Matched Record*
OP1ØØ	5OPØ1CE	1	OPNAV FORM 1ØØØ/4A	}
OPØ1CE	5OP1ØØ	Ø	CURRENT MIL PROF REQMTS	}
OP1Ø2	5OP1ØØ	1	MNPWR RQMT PLN CH 1ØØØ/4	}
OP124	9OP1ØØ	1	BILLET FILES	}
OP1ØØ	9OP124	Ø	NON-ZERO BALANCED 1ØØØ/2	
OP1ØØ	1OP1Ø1	1	OPNAV FORM 1ØØØ/4A	
OP1Ø1	1OP1ØØ	Ø	MOB MANP REQMTS 1ØØØ/4A	
OP1ØØ	3OP1Ø2	1	OPNAV INST 1ØØØ/16 SERIES	
OP1Ø2	3OP1ØØ	Ø	OPNAVINST 1ØØØ/16	
OP1ØØ	4OP1Ø2	1	STATUS VAR CODES + BILLET	
OP1Ø2	4OP1ØØ	Ø	SELECT MPWR RPTS + TABLES	
OPØ1CE	4OP1Ø2	1	CURRENT BILLET LIST	
OP1Ø2	4OPØ1CE	Ø	SELECT MPWR RPTS + TABLES	
OP1ØØ	4OP1Ø3	1	PROGRAMMING DECISIONS	
OP1Ø3	4OP1ØØ	Ø	MARP IMPLMTN LTRS	
OP1Ø2	4OP1Ø3	1	MARP FILE/MARP ADJ	
OP1Ø3	4OP1Ø2	Ø	MARP IMPLMTN LTRS	
OP1Ø2	9OP1Ø3	1	END YR STRENGTHS	
OP1Ø3	9OP1Ø2	Ø	END STRENGTH CNTRL MEMO	
OP1Ø4	9OP1Ø3	1	FYDP MANPOWER REQUIREMENT	
OP1Ø3	9OP1Ø4	Ø	END STRENGTH CNTRL MEMO	
OP1ØØ	9OP1Ø3	1	END STRENGTH CONT MEMO	
OP1Ø3	9OP1ØØ	Ø	END STRENGTH CNTRL MEMO	
OP1ØØ	2OP1Ø4	1	OFF/ENL SPECIALTY GUIDAN	
OP1Ø4	2OP1ØØ	Ø	FF + ENL SPECIALTY GUIDAN	
OP1ØØ	5OP124	1	APPROVED SHIP/SQUAD MAN	
OP124	5OP1ØØ	Ø	ALTRN USE APPROVED MPWR	

*The match is determined by the "Tag" at left.
Actual names may not match due to nominal variations
Among respondents in referring to the same communication.

To analyze the attributes of the 36 records saved on file EXCL1, the user initiates the CAP program by typing:

```
CAP
```

The CAP program responds by displaying:

```
PLEASE TYPE YOUR INPUT FILE NAME
```

The user then types:

```
EXCL1
```

CAP inquires about the kind of records on the file by displaying:

```
ARE YOUR RECORDS MATCHED OR UNMATCHED?
TYPE M OR U.
```

In this example, the records are matched, and the user types:

```
M
```

CAP then begins analyzing the matched records and creates or computes 80 attributes for each record. As stated before, for matched records CAP creates attribute information on 4 levels: communications, products, nodes, and the system.

The user is then able to make selections of records at any level by sequentially inputting attribute criteria at the terminal. A record must meet all attribute criteria input by the user to be included in the final subset. The user may display the final subset of records, along with the 80 attributes that correspond to each record, on the terminal. If the selection is made from the communication level (level 1), the user may save the final subset of this selection on a file to be used later on by one of the TISA programs.

At the start of CAP, the user is asked:

```
PLEASE TYPE YES TO OBTAIN ATTRIBUTE NUMBERS
AND DEFINITIONS.  TYPE NO OTHERWISE.
```

A user unfamiliar with the contents of the attribute information would type:

```
YES
```

This list may then be used as a reference in the selection process. CAP next asks the user if he wants selection instructions by displaying:

```
PLEASE TYPE YES TO OBTAIN SELECTION INSTRUCTIONS
TYPE NO OTHERWISE.
```

Again a new user wants to obtain instructions on how to make selections via the terminal and types:

YES

Now the user is ready to make selections.

The selection process begins by asking:

```
WHICH LEVEL DO YOU WISH TO SEE?
TYPE 1 FOR LEVEL 1 -- COMMUNICATIONS
TYPE 2 FOR LEVEL 2 -- PRODUCTS
TYPE 3 FOR LEVEL 3 -- NODES
TYPE 4 FOR LEVEL 4 -- SYSTEM
```

In example 1, the user first wants to look at the system level and types:

4

The user is then given the appropriate selection number:

SELECTION NUMBER 1

At this point the program is awaiting the user's specification of values for one or more of the 80 attributes calculated at the system level. However, it should be pointed out that if a general report on all of the attributes at any level was desired, this could be obtained by simply specifying in the first selection:

01GEO.

That is, find all the communications that have a value of zero or greater for attribute number one (potential contribution). This set necessarily includes all of the records in the original set (the range of attribute #1 being 0-4). A display of these records could then be requested and in this way complete sets of attribute averages can be obtained for any or all of the four levels of aggregation. Table A-II presents a condensed form of such averages at the system level (i.e., 4), using the Example 1 data set. A total of 31 records, 18 consumer and 13 producer, is indicated. This does not conflict with the original total of 36 matched records, but simply reflects the elimination of duplicate producer records from the average computations (i.e., where two or more consumers receive the same product). It should also be noted that these system level averages are correctly computed directly from the communications level data and do not represent averages of the product, or node level averages.

Table A-II

Report of Averages for System Level, Example 1

ABOVE CRITERIA MET BY BELOW CANDIDATES

ATTRIBUTES 1-22

SYSTEM VIEW	A1	A2	A3	A4	A5	A6	A7	A8
18 CONSUMERS	3.50	77.00	80.50	2.23	3.05	.648	0.	0.
	.000	.000	.000	.000	2.22	3.17	2.78	6.08
	.903	.708	.980	.656	.838	1		
13 PRODUCERS	3.38	84.77	85.62	2.60	3.62	.711	500887.	575510.
	.141	.088	.168	.108	3.23	0.77	0.00	7.92
	.904	.756	.942	.662	.891	0		

PLEASE PRESS RESET PAGE AND CARRIAGE RETURN

ATTRIBUTES 23-80

SYSTEM VIEW	A23	A24	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34
18 CONSUMERS	3	1	11	14	8	9	1	0	17	18	13	6
	1	0	6	4	7	1	3	3	2	12	4	2
	50	85	61	72	61	72	94	99	94	94	77	89
	66	99	72	61	61	94	83	73	61	44	61	88
	0	0	0	0	0	0	0	0	0	0		
13 PRODUCERS	7	1	5	10	9	8	0	0	13	12	11	3
	5	0	1	6	9	0	3	2	4	3	4	1
	50	88	61	72	61	72	94	99	94	94	77	50
	68	99	72	61	61	94	83	72	61	44	61	88
	0	0	0	0	0	0	0	0	0	0		

PLEASE PRESS RESET PAGE AND CARRIAGE RETURN

Let us assume that the user is now interested in specifying a particular subset of the original set based on multiple attribute criteria at the communication level of detail. Once the appropriate level is specified, the set elmination begins. The user's first request is to find all records with a computed benefit (attribute 4) greater than or equal to 2.0. To find these records, he types:

```
04GE2.
```

The CAP program responds by displaying:

```
NUMBER MEET THIS REQUEST = 21
NUMBER MEET ALL REQUESTS = 21
```

Twenty-one records are found meeting the first attribute criteria request. The second request wishes to find all records with a total cost (attribute 8) less than or equal to $25,000. To find these records, he types:

```
08LE25000.
```

The CAP program responds by displaying:

```
NUMBER MEET THIS REQUEST = 23
NUMBER MEET ALL REQUESTS = 16
```

So far 16 records have survived all attribute criteria requests. The user now has a third attribute request to ask:

```
26EQ1.
```

This request says find all records that contain quantitative information (attribute 26).

CAP responds by displaying:

```
NUMBER MEET THIS REQUEST = 24
NUMBER MEET ALL REQUESTS = 12
```

This is the final subset so the user presses carriage return. He does not want to show this subset, but he does want to save it. The CAP program responds:

```
PLEASE TYPE IN SAVE FILE NAME
```

The user then types the save filename:

```
SAVE1
```

The subset is saved on SAVE1 and the user elects the option of ending the CAP program. The TISA executive program displays:

```
NEXT:
```

In this case the user wants to look at the Network Analysis Program, so he types:

```
NAP
```

The NAP program responds with the display of:

```
OK
```

The user allows for NAP to read the saved file by typing:

```
READ SAVE1
```

After NAP responds with an OK, the user must make a command. In this case, he elects:

```
DRAW UNIVERSE
```

Communications flows in the terms of functional block diagramming graphics are displayed for this subset and can be found in Figure A-1.

Using NAP's powerful set manipulation commands, the user can see how the OP-103 organization interacts with the OP-102 organization. He would type at the terminal the following commands:

```
LET SET1 = FOLLOWS (#OP103) BY 0-4
LET SET2 = PRECEDES (#OP102) BY 0-4
LET SET3 = INTERSECTION(SET1, SET2)
DRAW SET3
```

The functional block diagram (FBD) is shown in Figure A-2.

If the user wants to add a feedback loop from OP-102 to OP-103 and call the new communication OP-102-1, the user types the NAP command:

```
CREATE #OP102-1
```

The user must also make the relevant new connections by typing the commands:

```
JOIN #OP102 to #OP102-1
JOIN #OP102-1 to #OP103
```

A new set including the feedback loop is created with the command:

```
LET SET4 = UNION(SET3, #OP102-1)
```

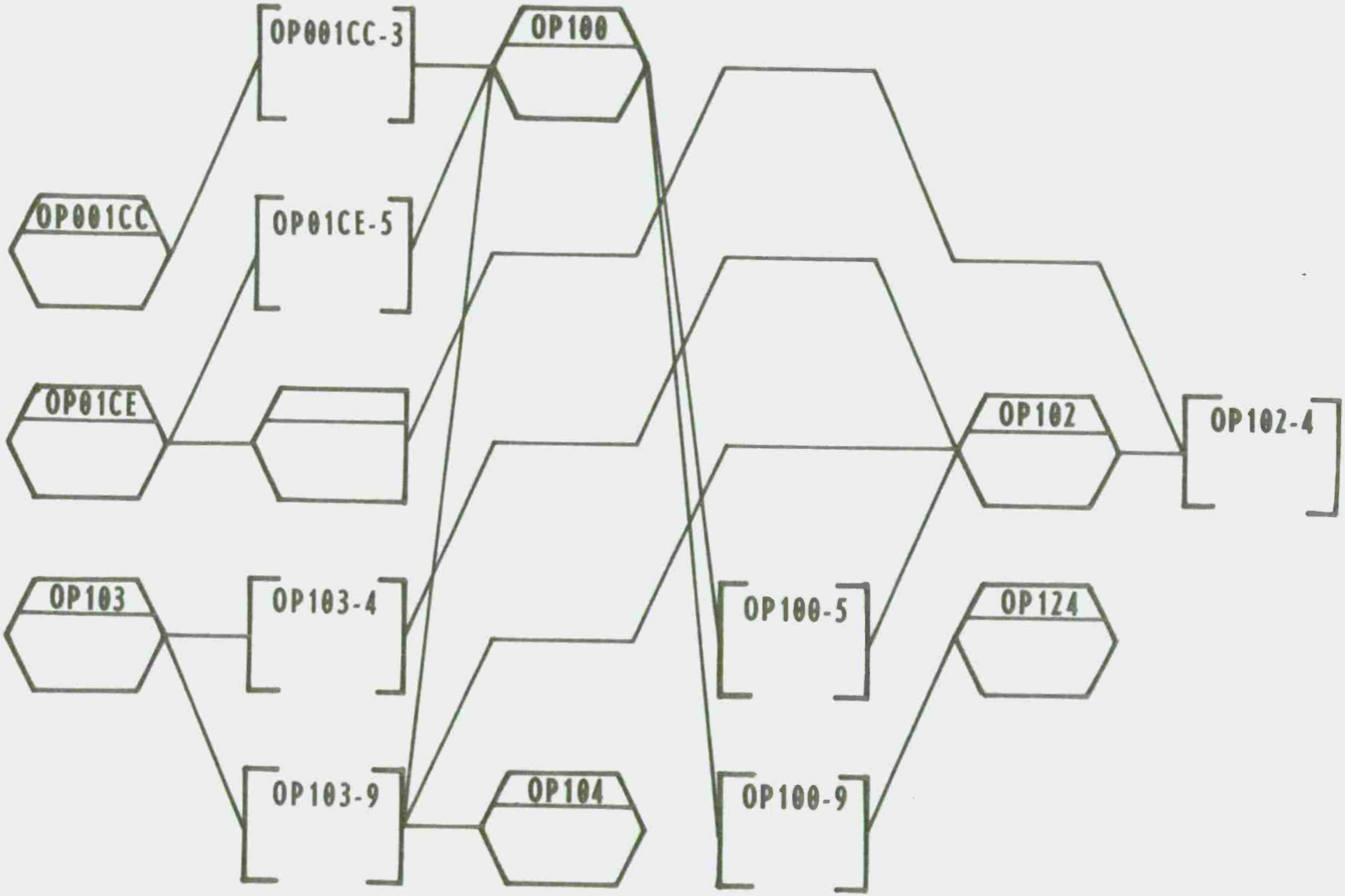
OP001CC-3
OP100
OP001CC
OP01CE-5
OP01CE
OP102
OP102-4
OP103
OP103-4
OP100-5
OP124
OP103-9
OP104
OP100-9

Figure A-1

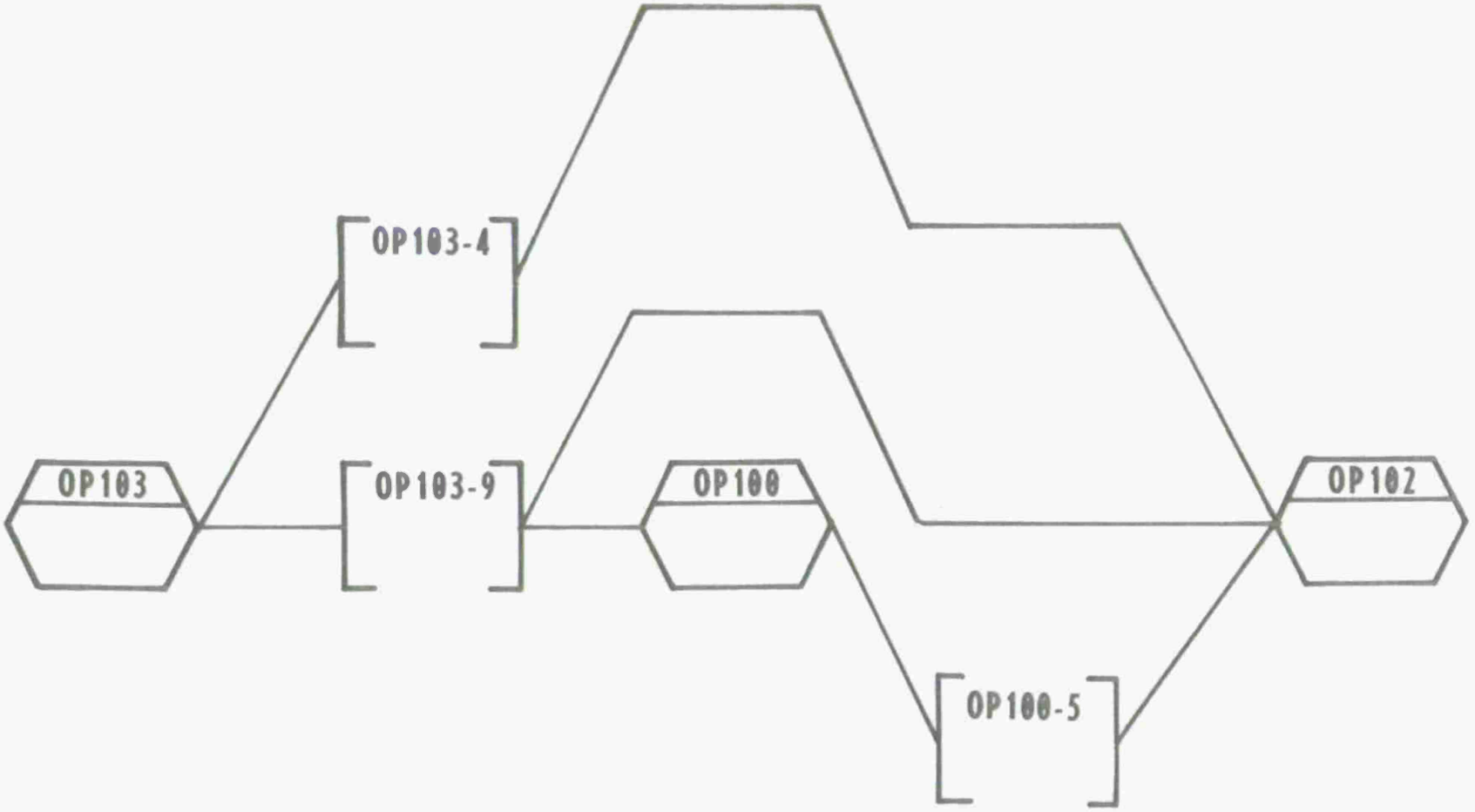

Figure A-2

The FBD, as shown in Figure A-3, is displayed by the command:

DRAW SET4

Example 2

In example 2 the user analyzes the OP-103 organization in terms of how the rest of the world views OP-103's inputs and outputs.

The user again starts with the SEARCH program. This time he searches on the communication identifier in the inclusive search. He inserts only OP103 to search on, and the SEARCH program responds at the end of the inclusive search with the display:

NUMBER OF RECORDS FOUND THIS SEARCH - 12
NUMBER OF RECORDS FOUND THUS FAR 12

The inclusive search file now contains all input and outputs of OP-103 recognized by the "universe" (i.e., the data base). In the current example data base these number 12. A list of the node codes, communication identifiers and communication names is shown in Table A-III. The user now ends the SEARCH program.

TABLE A-III

Node Code	Comm I. D.	Output No.	I/O Des	Communication Name
OPØØ4D	20P1Ø3		Ø	INCREMENTS/DECREMENTS POM
OP1ØØ	60P1Ø3		Ø	OPNAV FORM 1ØØØ/5
OP1ØØ	40P1Ø3		1	PROGRAMMING DECISIONS
OP1ØØ	90P1Ø3		1	END STRENGTH CONT MEMO
OP1Ø2	90P1Ø3		1	END YR STRENGTHS
OP1Ø2	40P1Ø3		1	MARP FILE/MARP ADJ
OP1Ø4	90P1Ø3		1	FYDP MANPOWER REQUIREMENT
OP121	70P1Ø3		Ø	MANAG SYS IMPROV
OP94P252	0P1Ø3		Ø	PROG IMPLEMENTATION/MONT
OP94P259	0P1Ø3		1	POM REQUIREMENTS
OP94P255	0P1Ø3		1	DNFYP/BUDGET
PER021	90P1Ø3		1	END YEAR STRENGTHS O + E

NUMBER OF RECORDS PRINTED - 12

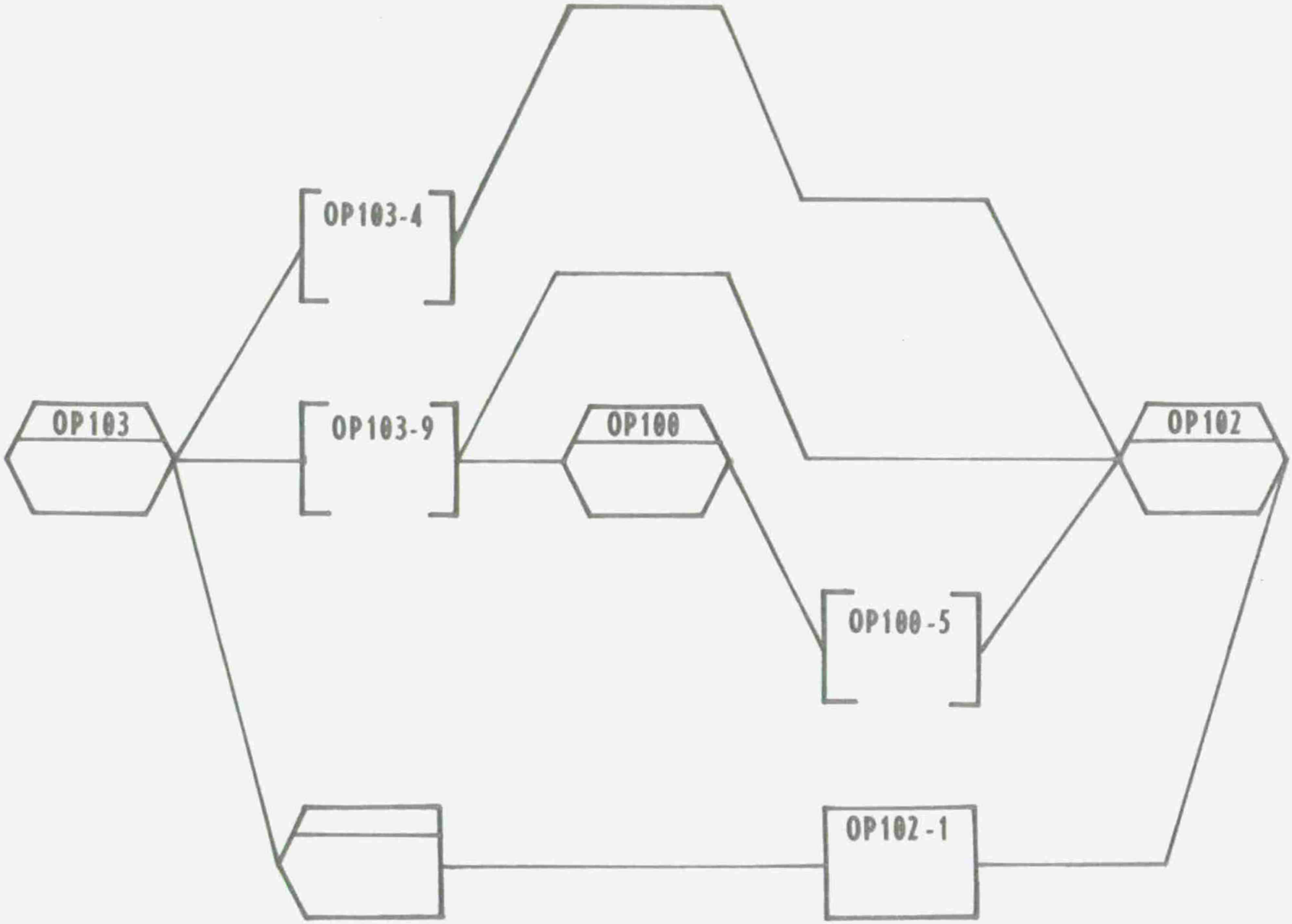

Figure A-3

CAP is called next and responds with the display:

PLEASE TYPE YOUR INPUT FILENAME

The user types the name of the inclusive search file in example 2:

INCL2

CAP inquires about the record type:

ARE YOUR RECORDS MATCHED OR UNMATCHED?
TYPE M OR U

This input file contains unmatched records so the user types:

U

CAP then creates for this unmatched record set, two levels of information: the communications level and the system level (since this is all that is possible with unmatched records).

The user, at the beginning of the interactive portion of CAP, suppresses the attribute list and selection instructions (this information is available from example 1). To display the whole set of records at the communications level, the user gets into level 1 selection and types:

01GE0.

This command finds all 12 records. Table A-IV displays all 12 records and their first 22 attributes. The user saves these records in the filename SAVE2.

The user then indicates that he wants to make another selection and enters the selection process this time at level 4, the system level. The first 22 system attributes for this example are displayed in Table A-V. OP-103 is recognized to receive 4 outputs from the universe and produce 8 inputs to the universe. The 4 outputs from the universe are of course OP-103's inputs, and the 8 inputs to the universe are OP-103's outputs. The average consumer view for OP-103's outputs for computed benefit (attribute 4) is 2.87. The average producer view for OP-103's inputs for computed benefit is 1.22. The annual cost of OP-103's inputs is $216,160. At this time the user ends the CAP program.

Table A-IV

ABOVE CRITERIA MET BY BELOW CANDIDATES

ATTRIBUTES 1-22

NCODE	IDCOM	A1	A2	A3	A4	A5	A6	A7	A8
OP004D	20P103	2.00	0.00	0.00	0.00	2.00	.000	0.	2770.
		.000	.000	.000	.722	1.00	0.00	0.00	2.00
		.000	.000	.000	.000	.000	0		
OP100	60P103	3.00	80.00	30.00	0.72	3.00	.240	0.	0.
		.000	.000	.000	.000	1.00	0.00	0.00	10.00
		.000	.000	.000	.000	.000	0		
OP100	40P103	4.00	99.00	80.00	3.20	4.00	.800	0.	0.
		.000	.000	.000	.000	3.00	4.00	3.00	5.00
		.000	.000	.000	.000	.000	1		
OP100	90P102	4.00	99.00	80.00	3.80	4.00	.800	0.	0.
		.000	.000	.000	.000	1.00	4.00	3.00	5.00
		.000	.000	.000	.000	.000	1		
OP102	90P103	4.00	85.00	85.00	2.89	2.00	.722	0.	0.
		.000	.000	.000	.000	2.00	4.00	3.00	10.00
		.000	.000	.000	.000	.000	1		
OP102	40P103	4.00	85.00	95.00	3.23	2.00	.807	0.	0.
		.000	.000	.000	.000	2.00	4.00	3.00	10.00
		.000	.000	.000	.000	.000	1		

PLEASE PRESS RESET PAGE AND CARRIAGE RETURN

NCODE	IDCOM	A1	A2	A3	A4	A5	A6	A7	A8
OP104	90P103	4.00	99.00	99.00	4.00	4.00	1.000	0.	0.
		.000	.000	.000	.000	1.00	4.00	4.00	10.00
		.000	.000	.000	.000	.000	1		
OP121	70P103	2.00	80.00	90.00	1.44	3.00	.720	0.	207850.
		.000	.007	.000	.014	2.00	2.00	1.00	1.00
		.000	.000	.000	.000	.000	0		
OP94P252	0P103	3.00	95.00	95.00	2.71	4.00	.903	0.	5540.
		.000	.489	.000	.722	4.00	0.00	0.00	2.00
		.000	.000	.000	.000	.000	0		
OP94P259	0P103	3.00	95.00	50.00	1.43	2.00	.475	0.	0.
		.000	.000	.000	.000	3.00	3.00	3.00	2.00
		.000	.000	.000	.000	.000	1		
OP94P255	0P103	4.00	99.00	99.00	4.00	4.00	1.000	0.	0.
		.000	.000	.000	.000	4.00	3.00	3.00	2.00
		.000	.000	.000	.000	.000	1		
PER021	90P103	4.00	50.00	50.00	1.00	2.00	.250	0.	0.
		.000	.000	.000	.000	2.00	2.00	3.00	0.00
		.000	.000	.000	.000	.000	1		

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Table A-V

ABOVE CRITERIA MET BY BELOW CANDIDATES

	ATTRIBUTES 1-22							
SYSTEM VIEW	A1	A2	A3	A4	A5	A6	A7	A8
8 CONSUMERS	3.87	88.88	79.75	2.87	3.00	.700	0.	0.
	.000	.000	.000	.000	2.25	3.50	3.13	5.50
	.000	.000	.000	.000	.000	1		
4 PRODUCERS	2.90	63.75	53.75	1.22	3.00	.400	0.	216100.
	.000	.124	.000	.305	2.00	0.50	0.25	3.75
	.000	.000	.000	.000	.000	0		

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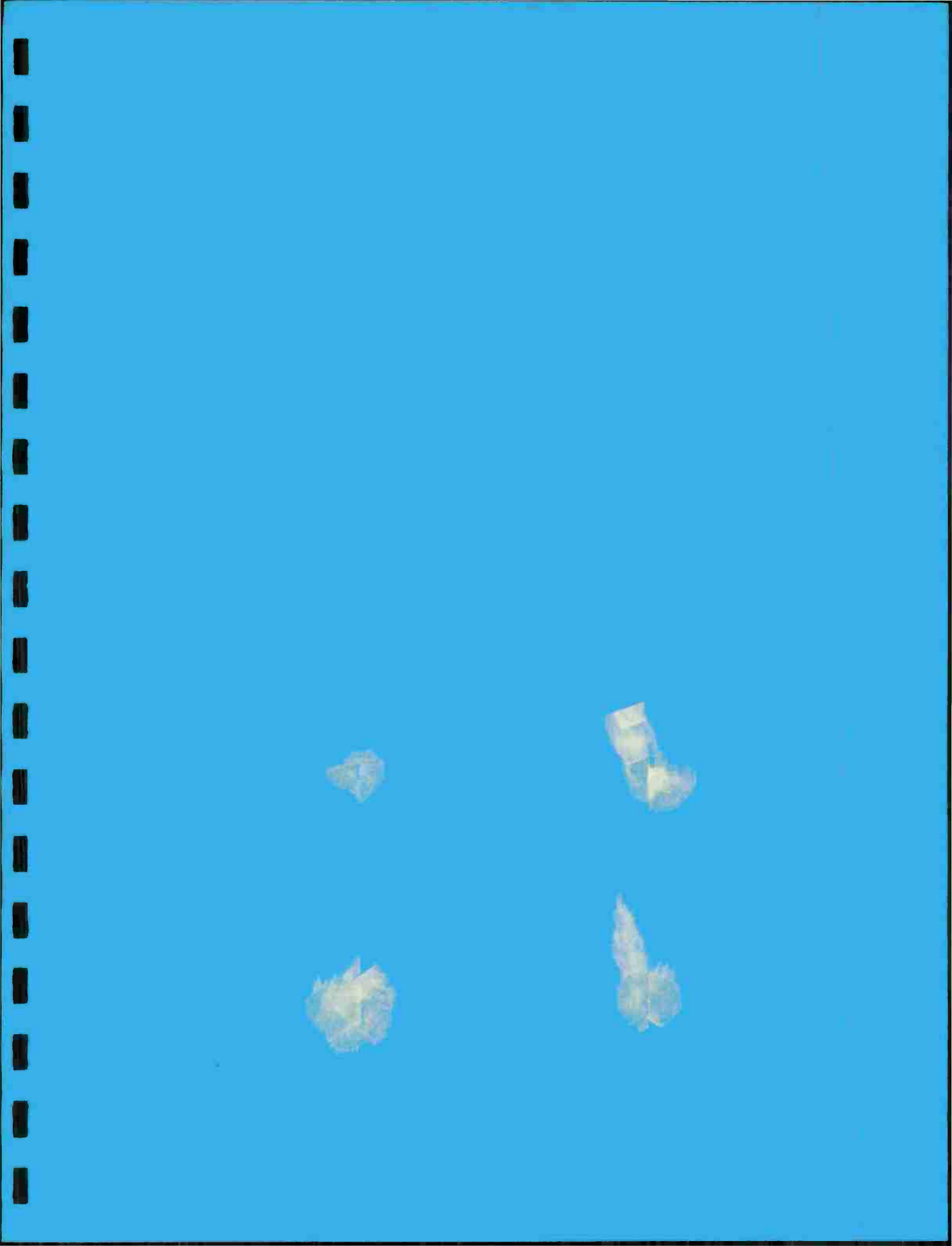

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